IGCSE MY NOTES
Chapter 1 General Physics
Prepared by: Chern Jiek Lee

1.0 Making measurements

SI Units – International System of Units

1.1 Length and Time

Ruler is used to measure **length** for distances between 1 mm and 1 meter.

SI unit: _______ ( )

What happens if you want to measure less than 1mm?
Refer to handout!

To measure the volume of a regular object you will need to know the formula and several of its length. For eg. to measure the volume of a solid box, you'll need its height x length x width.

To measure the volume of an irregular object you put the object in a measuring cylinder with water and measure the rise in water. The rise in water is the volume of the object.

Time is measured using clocks.

SI unit: _______ ( )

To measure the period of a pendulum ______________________________
____
____
____
____
______

1.2 Speed, Velocity and Acceleration

Distance: The distance travelled by an object is the total length that is travelled by that object.

SI unit: _______ ( )

Speed: *Rate of change* in __________.

SI unit: meter per second (m/s)
Quantity: scalar

$$v = \frac{d}{t}$$

v is the speed, d is the distance travelled and t is the time taken

Velocity: *Is speed with a given direction!*

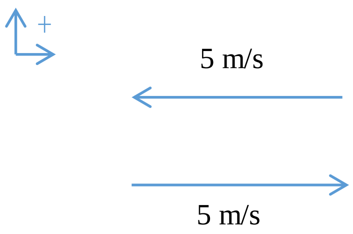
SI unit: meter per second (m/s)
Quantity: vector

$$v = \frac{s}{t}$$

v is the speed, *s* is the displacement and *t* is the time taken

Note: In velocity the positive/ negative sign indicates direction.

eg.



Speed of top arrow:
Velocity of top arrow:
Speed of bottom arrow:
Velocity of bottom arrow:

Acceleration: *Rate of change* of velocity.

SI unit: _________________(____)
Quantity: vector

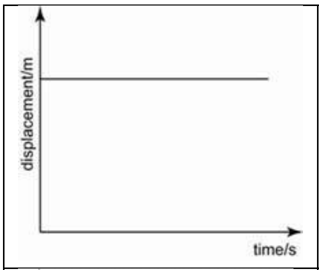
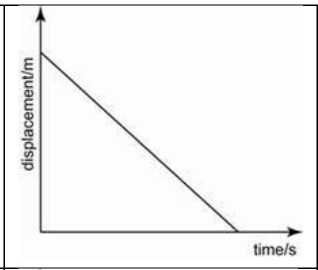
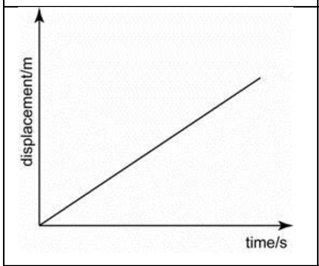
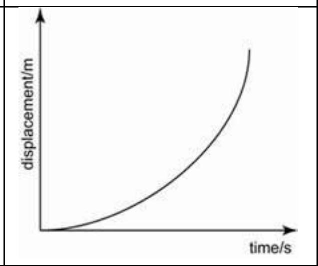
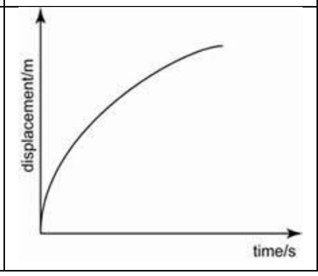
$$a = \frac{v - u}{t}$$

v is the speed, *s* is the displacement and *t* is the time taken

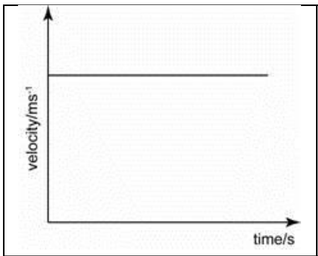
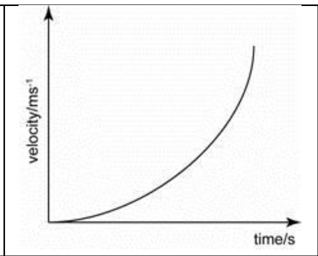
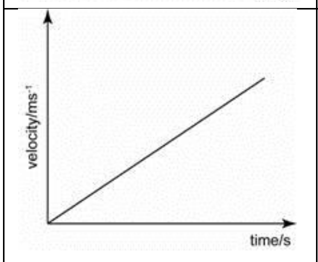
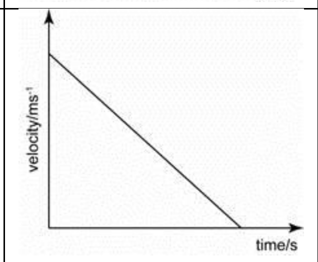
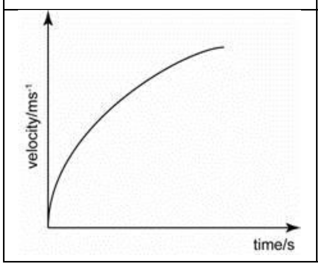
Direction	+	+	-	-
Change of speed	+	-	+	-
Acceleration	+	-	-	+

Note: Negative acceleration IS NOT deceleration!!!!!

Displacement-Time graph

Velocity-Time graph

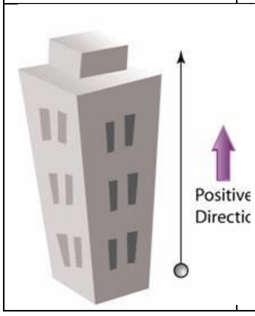
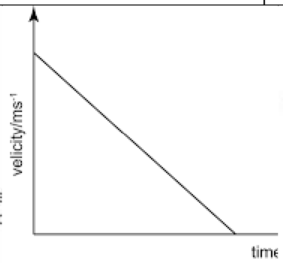
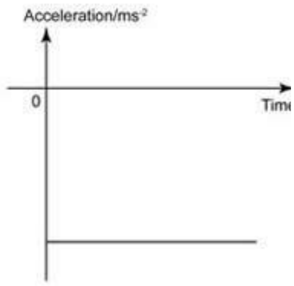
Which of the above does not have a constant acceleration.

Flex your brain!

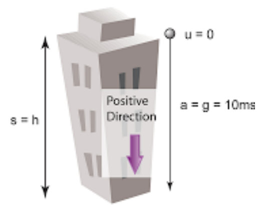
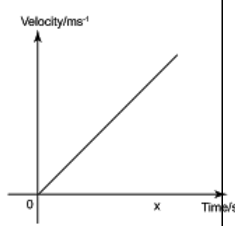
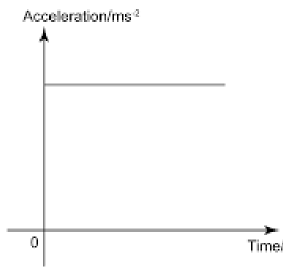
A car starts from rest and accelerates at a constant acceleration of $3m/s^2$ for 10 seconds. The car then travels at a constant velocity for 5 seconds. The brakes are then applied and the car stops in 5 seconds. What is the total distance travelled by the car?

Free falling: Free falling is a motion under gravitational force as the only force acting on the moving object. The acceleration of a free falling object is always always always *constant*. On the surface of the earth, the acceleration due to gravity, *g* is equal to $10ms^{-2}$. In reality objects are slowed by air resistance. Once air resistance is equal to the force of gravity, the object stops accelerating. The object is said to have reached **terminal velocity**.

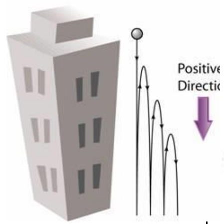
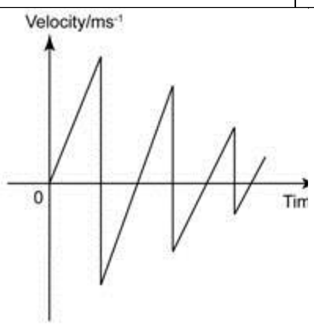
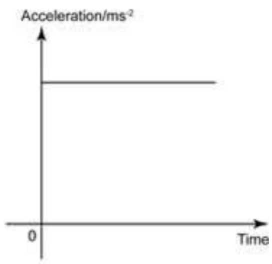
<u>Launching Object Upward</u>

Motion	Velocity-Time Graph	Acceleration-Time Graph
		

<u>Dropping Object from a High Place</u>

Motion	Velocity-Time Graph	Acceleration-Time Graph
		

<u>Object Falling and Bounce Back</u>

Motion	Velocity-Time Graph	Acceleration-Time Graph
		

Visualization based question

Assuming an object is free falling, what is the

a) Speed

b) Distance

After 10s, 20s, 30s?

1.3 Mass and Weight

Mass: Mass is defined as the amount of matter in an object.
SI unit: kg

Inertia: Property of a body that tends to maintain its state of motion.

Newton's 1st Law: In the absence of external forces, an object at rest remains at
_______ and an object in motion continues in _________ with a constant velocity.

Weight: Is the force of gravity acting on an object.
SI unit: Newtons

Weight = mass x gravitational acceleration

1.4 Density

Density: Is defined as mass per unit volume.
SI unit: _______ ( )

1.5 Force

Force: Push or pull exerted on an object. Can change the shape and size of an object. Can even change the direction, deceleration or acceleration of an object depending on direction.

SI unit: Newton (or $kgms^{-1}$)

Newton's 2nd law: States that the acceleration of an object is directly proportional to the resultant force acting on the object and inversely proportional to mass. So basically

$$F = ma$$

When the forces acting on an object are not balanced, there must be a net force acting on it. This net force is known as the unbalanced force.

Where F is the force, m is the mass and a is the acceleration. Hence, the resultant force will cause an object to accelerate.

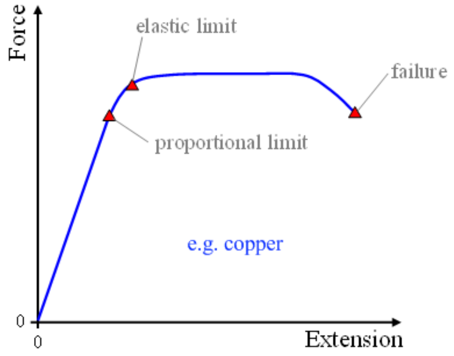
Hooke's Law: Springs extend in proportion to loads, as long as they are under their proportional limit.

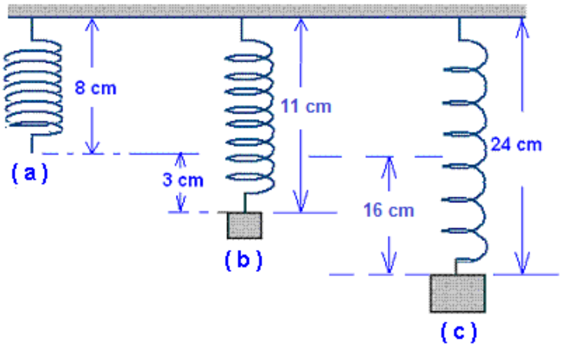
Limit of proportionality: Point and which load and extension are no longer proportional.

Elastic limit: Point at which spring will not return to its original shape even after the load is removed.

Find the resultant force and acceleration

A box of mass 150kg is placed on a horizontal floor with a smooth surface (which means no friction). Find the acceleration of the box when 300N force is pulling it to the left and 600N is pulling it to the right. *Hint: Whenever there's more than 1 force acting on an object you'll need to find the resultant force. Draw out the problem!*





Circular motions: An object at steady speed in a circular orbit is always accelerating as its direction is changing, but it gets no closer to the centre

Centripetal force: is the force acting towards the centre of a circle. It is a force that is **needed** (not caused by) a circular motion, for example when you swing a ball on a string round in a circle, the tension of the string is the centripetal force. If the string is cut then the ball will travel in a straight line at a tangent to the circle at the point where the string was cut (Newton's first law)

SI unit: _______ ( )

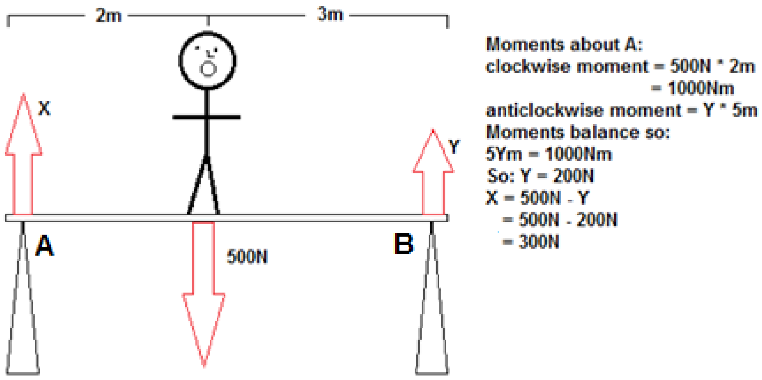
Centripetal force = mass × velocity^2 / radius

Newtons 3rd law: if object A exerts a force on object B, then object B will exert an equal but opposite force on object A
or, more simply:

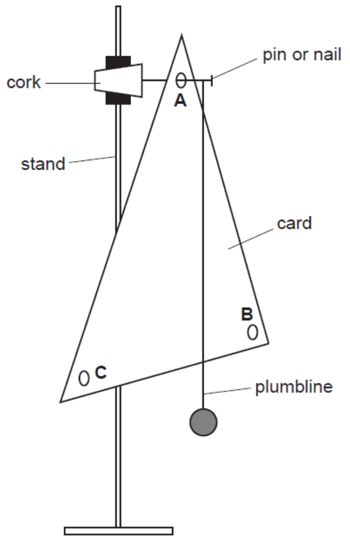
To every action there is an equal but opposite reaction

Centrifugal force also known as the **non-existent force** is the force acting away from the centre of a circle. This is what makes a slingshot go outwards as you spin it. The centrifugal force is the reaction to the centripetal force (Newton's third law). It has the same magnitude but opposite direction to the centripetal force ("equal but opposite").

Turning effect: Moments of a force are measured in Newton meters, can either be clockwise or anticlockwise. **Equilibrium** is achieved when the clockwise moment = anticlockwise moments.



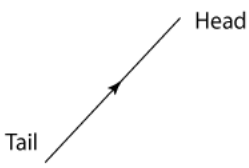
Center of mass is an imaginary point in a body (object) where the total mass of the body can be thought to be concentrated. For stability the centre of mass must be over the centre of pressure.



To find the center of gravity on a flat object, ________________________

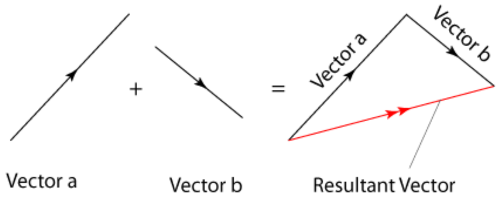
____
____
____
____

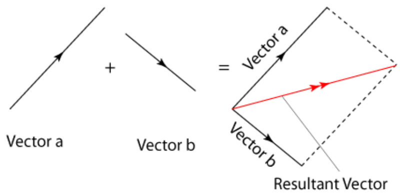
Scalar: Quantity which can be fully described by magnitude only.
Vector: Quantity which can be fully described by both magnitude and direction



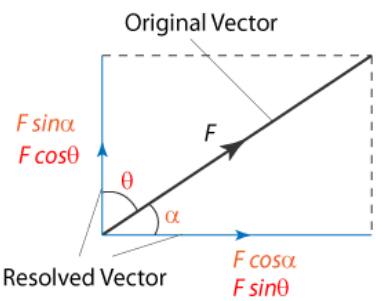
Vector Diagram

Vectors can be added through the use of triangle or parallelogram method.

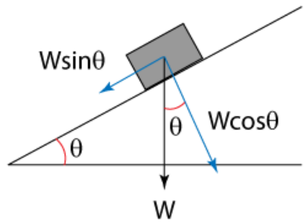




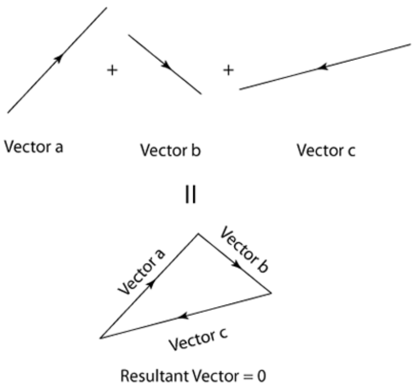
Vector's can be resolved into horizontal and vertical component.

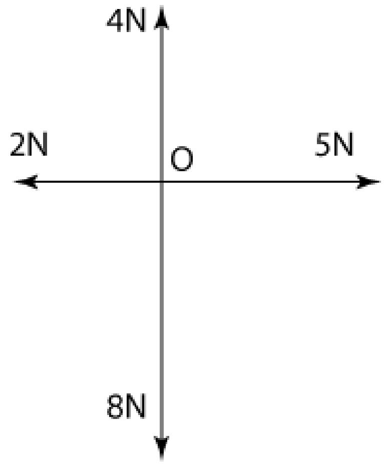


eg.



Vectors in equilibrium





Find the resultant force by using

a) Triangle method

b) Calculation

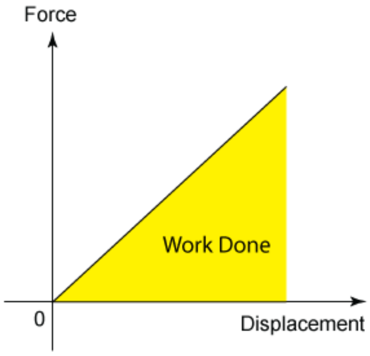
1.6 Work

Work: Done by a constant force to move an object a certain _________.
SI unit: Nm (Newton metre) or J(Joule)
Quantity: Scalar

$$W = F \times s$$

Where F is the force and s is the distance travelled.

Work done from a graph



On a force-displacement graph, the work done equals the area under the curve.

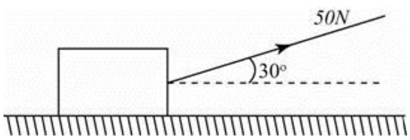
Energy: Is the capacity to do work.
SI units: Nm or Joule
Quantity: Scalar

Potential energy

1) **Gravitational potential energy**: The energy stored in an object as the result of its height.
SI units: Nm or Joule
Quantity: Scalar

$$W = mg \times h$$

where h is the relative height of the object.



A force of 50 N acts on the block at an angle of 30°. The block moves a horizontal distance of 3m. Calculate the work being done by the force.

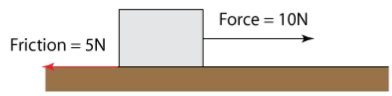


Diagram above shows a 10 N force is pulling a metal. The friction between the block and the floor is 5N. If the distance travelled by the metal block is 2m, find

a) the work done by the pulling force
b) the work done by the frictional force

2) **Elastic potential energy:** The energy stored in _______ materials when you
stretch or compress the spring.
SI units: Nm or Joule
Quantity: Scalar

$$W = \frac{1}{2}Fx$$

Where x is the length of the compressed or elongated spring.

<u>Kinetic energy</u>

Kinetic energy: The energy of a moving object.
SI units: Nm or Joule
Quantity: Scalar

$$W = \frac{1}{2}mv^2$$

Where v is the speed of the object.

Power: Is the rate at which work is done.
SI units: Watt or J/s
Quantity: Scalar

$$P = \frac{W}{t}$$

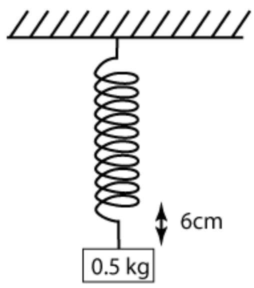
Where W is the energy or work done.

Efficiency: The percentage of usable energy.
SI units: dimensionless or %
Quantity: dimensionless

$$\eta = \frac{Output}{Input} \times 100\%$$

Ah Kau climbs 35 steps of a staircase. Each steps is 10cm in height. If Ah Kau weighs 45kg, find the work done by him to reach the top of the 35 steps.

Determine the kinetic energy of a 2000kg bus that is moving at a speed of 35m/s.



Find the energy stored in the spring.

Energy sources can come from renewable or non-renewable sources.

Renewable source of energy is inexhaustible, for eg. solar, hydroelectric, wind, etc. eg. hydro dams, tidal power scheme, wave energy, geothermal resources, nuclear fission, solar cells, solar panels.

Non-renewable source of energy: is exhaustible for example fossil fuels. Eg, fossil fuel.

The conservation of energy principle states that energy cannot be created or destroyed by can change from one form to another.

1.7 Pressure

Pressure, *P* is the **force, *F*** exerted per unit **area, *A***

$$P = \frac{F}{A}$$

Gas pressure: The force exerted by air molecules.

Liquid pressure: The force exerted by _______ molecules.

The SI unit for force is ___________.

The SI unit for area is ____________.

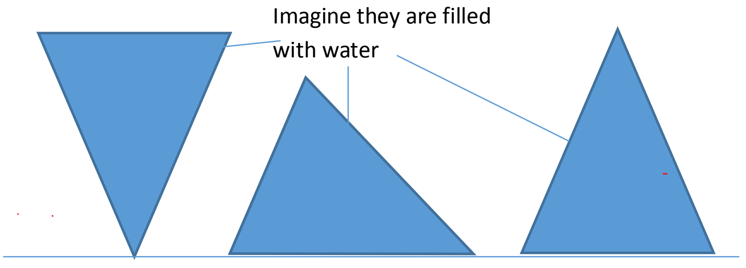
The SI unit for pressure is then ____________ or ________.

Give some examples for the application of pressure.

____

Which of the following orientation do you think exerts the biggest force on the surface? *Hint: think about the area*

____

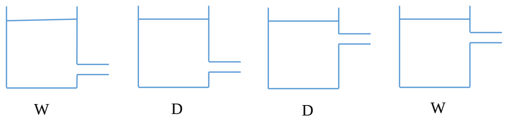


Calculate the pressure exerted on the surface for each orientation assuming the mass of the object is 100kg. The contact area for each orientation is $0.001m^2$, $0.1m^2$ $0.01m^2$ respectively. *Hint: Recall Chapter 1*

The Pressure Exerted by Liquids

Fluids exert pressure on the fluids below due the *weight* of the fluid. The pressure acts in all directions. The 3 factors affecting fluid pressure are the *depth* and *density* of the fluid and *acceleration due to gravity*.

Which of the following do you think will "shoot" the farthest? *Hint: Density of*
D < Density of W. Think logically…….



Why?

____

Rewrite the pressure formula in terms of ρ, *h and g*.

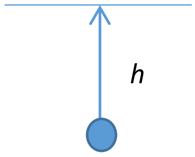
Hint 1 Write out the "original" pressure formula

Hint 2 What is the equation for weight (or force)?

Hint 3 Mass is equal to density x volume

Hint 4 Volume is equal to area x height of the fluid.

Hint 5 Assume both area are the same.



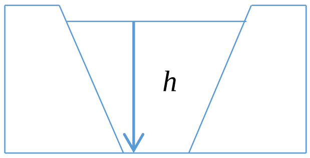
What is the pressure exerted by the water on the bubble assuming *h* is

a) 1m?

b) 5m?

c) 10m?

Hint: Density of water is 1000 kgm^{-3}



Calculate the depth of the water if the maximum pressure at the base of the dam is 750 kPa.

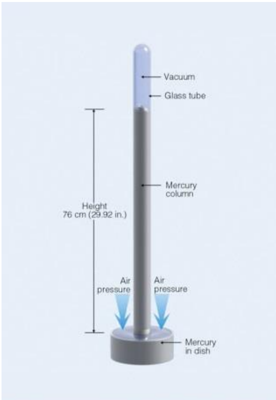
Sketch the graph of pressure vs the depth of the water.
Hint: 0 meters starts from the surface of the water.

The Pressure Exerted by Gas

Recall the kinetic theory of gas. The theory assumes that

1) Gas particles are infinitely small and located far from each other
2) Gas molecules are in fast and continuous motion and collide with each other. Think Brownian motion.
3) This collision with each other is perfectly elastic

So gas pressure is a result of the perfectly elastic collision of gas molecules with anything. An example of pressure exerted by gas is all around you; it's called atmospheric pressure. The value of atmospheric pressure is 1 atm at sea level. When you go above sea level, this value *increases/ decreases*. When you go below sea level this value *increases/ decreases*.



© 2007 Thomson Higher Education

A **mercury barometer** is used for measuring atmospheric pressure. Base on the height, *h* of the mercury the pressure of the atmosphere can be determined. 1 atm = 0.76 meters of Hg (760 mm Hg). Proof:

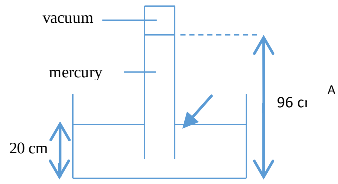
Density of mercury, ρ = 13600 kgm^{-3}
Gravitational acceleration of the earth, g = 9.82 ms^{-2}

Using $P = h\rho g$ (you can use this formula because both mercury and the atmosphere are fluids), proof that atmospheric pressure, P = 1 atm = 1.01×10^5 Pa.

From above you can see that, when pressure increases the height of the mercury *increases/ decreases*. Likewise when the pressure decreases the height of the mercury *increases/ decreases*.

A mercury barometer is hard to carry around (and potentially hazardous to your health!). A **manometer** is more practical for day to day measurement of gas pressure.

Let's say this Hg barometer is placed in a room.



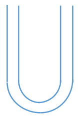
Based on this reading, calculate

1) The atmospheric pressure in the room in both mm Hg and Pa.

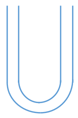
2) The pressure at point A.

3) The pressure at point B.

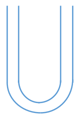
When both arms are not connected to anything



When one arm is connected to a gas supply and the gas pressure > atmospheric pressure



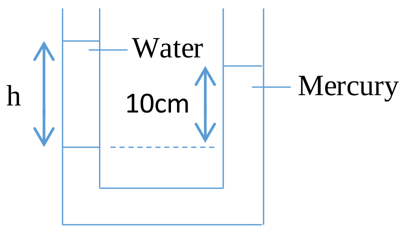
When one arm is connected to a gas supply and the gas pressure < atmospheric pressure



There are several steps in order to find pressure using a manometer.

Step 1 Draw equal pressure lines. Remember the pressure is only the same for same fluids.
Step 2 Draw arrows showing the direction of force caused by the weight of the Fluids on the equal pressure lines.
Step 3 Write the relevant equations down.
Step 4 Solve the problem

Try the problem below using the steps above:



The manometer consists of water and mercury. You are asked to find *h*.

Step 1 Draw equal pressure lines. *Hint: It's obvious this time.*

Step 2 Draw arrows showing the direction of force caused by the weight of the fluids. *Hint: Both arms are exposed to the atmosphere*

Step 3 Write the relevant equations down. *Hint:* $P = h\rho g$

Step 4 Solve the problem